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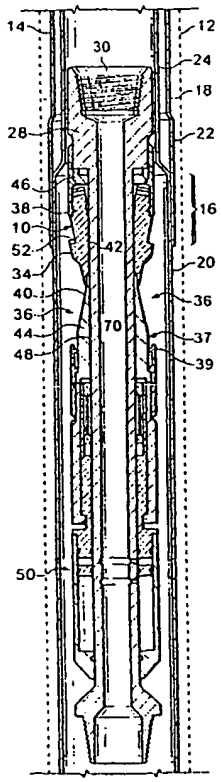
(54) Title: CUTTER FOR WELLBORE CASING



(57) Abstract: A cutter for a wellbore casing is provided that includes a rotatable tubular support, at least one cutter blade supported on the rotatable tubular support, having a retracted position for insertion into the wellbore casing and having an expanded position for cutting engagement with the wellbore casing, and an actuator for moving the cutter blade from the retracted position to the expanded position for cutting engagement with the wellbore casing.

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CUTTER FOR WELLBORE CASING

Cross Reference To Related Applications

[001] The present application claims the benefit of the filing date of (1) U.S. provisional patent application serial no. 60/412,487, attorney docket no 25791.112, filed on 9/20/2002, , the disclosure of which is incorporated herein by reference.

[002] The present application is related to the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent no. 6,328,113, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (24) U.S. provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (29) U.S. utility

patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, (30) U.S. utility patent application serial no. 10/016,467, attorney docket no. 25791.70, filed on 12/10/2001, (31) U.S. provisional patent application serial no. 60/343,674, attorney docket no. 25791.68, filed on 12/27/2001, (32) U.S. provisional patent application serial no. 60/346,309, attorney docket no 25791.92, filed on 1/7/2002, (33) U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/2002, (34) U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002, (35) U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/2002, (36) U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002, (37) U.S. provisional patent application serial no. 60/391,703, attorney docket no. 25791.90, filed on 6/26/2002, (38) U.S. provisional patent application serial no. 60/397,284, attorney docket no. 25791.106, filed on 7/19/2002, (39) U.S. provisional patent application serial no. 60/398,061, attorney docket no. 25791.110, filed on 7/24/2002, (40) U.S. provisional patent application serial no, 60/405,610, attorney docket no. 25791.119, filed on 8/23/2002, (41) U.S. provisional patent application serial no. 60/405,394, attorney docket no. 25791.120, filed on 8/23/2002, (42) U.S. provisional patent application serial no. 60/412,177, attorney docket no. 25791.117, filed on 9/20/2002, (43) U.S. provisional patent application serial no. 60/412,653, attorney docket no. 25791.118, filed on 9/20/2002, (44) U.S. provisional patent application serial no. 60/412,544, attorney docket no. 25791.121, filed on 9/20/2002, (45) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.128, filed on 9/20/2002, (46) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.127, filed on 9/20/2002, (47) U.S. provisional patent application serial no. 60/412,542, attorney docket no. 25791.102, filed on 9/20/2002, and (48) U.S. provisional patent application serial no. 60/412,488, attorney docket no. 25791.114, filed on 9/20/2002, the disclosures of which are incorporated herein by reference.

Background of the Invention

[003] This invention relates generally to oil and gas exploration, and in particular to forming and repairing wellbore casings to facilitate oil and gas exploration.

[004] Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves

increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

[005] The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming and/or repairing wellbore casings.

Summary of the Invention

[006] According to one aspect of the present invention, a cutter for an expandable wellbore casing is provided.

Brief Description of the Drawings

[007] Fig. 1 shows a schematic fragmentary cross sectional illustration of a casing cutter tool in a wellbore casing, with the cutter tool in a retracted non-cutting configuration and at a location in the wellbore casing below an overlapping joint between an expanded upper casing section and a partially expanded lower section that are joined together at an overlapping joint in a nested arrangement to form a mono diameter wellbore casing according to one aspect of the invention.

[008] Fig. 2 shows a schematic fragmentary cross sectional illustration of the casing cutter tool of Fig. 1 in an expanded cutting configuration according to one embodiment of the invention.

[009] Fig. 3 shows a schematic fragmentary cross sectional illustration of the casing cutter tool of Fig. 2 with an actuation device shown in a configuration for expanding cutter blades radially outward into a cutting position.

[0010] Fig. 4 shows a schematic fragmentary cross sectional illustration of the casing cutter tool of Figs. 1 - 3 raised to a location in the expanded portion of the lower wellbore casing for engaging with an unexpanded portion of the lower casing that projects above the overlapping joint of the upper and lower wellbore casing sections.

[0011] Fig. 5 shows a schematic fragmentary cross sectional illustration of the casing cutter tool of Figs. 1 – 4 further raised in the wellbore casing and rotated with radially projecting cutter blades engaged with the unexpanded portion of the lower casing.

[0012] Fig. 6 shows a schematic fragmentary cross sectional illustration of a casing cutter tool of Figs. 1 – 5 with radially projecting cutter blades severing the unexpanded portion of the lower casing and with the severed portion supported by the cutter tool for lifting it out of the wellbore.

[0013] Fig. 7 shows a schematic fragmentary cross sectional illustration of a casing cutter tool with an actuation device shown in a configuration for retracting cutter blades radially inward into a non-cutting position.

[0014] Fig. 8 shows a cross-section through an exemplary embodiment of the expander device for a cutter tool with cutter blades of the cutter tool in an expanded cutting position.

Detailed Description of the Illustrative Embodiments

[0015] Figs. 1-5 illustrate several illustrative embodiment of a cutter tool 10 in a wellbore 12 for forming a mono diameter wellbore casing 14 and the method of using the cutter tool 10. In several alternative embodiments, the invention is implemented using the methods and/or apparatus disclosed one or more of the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent no. 6,328,113, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (24) U.S. provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (29) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, (30) U.S. utility patent application serial no. 10/016,467, attorney docket no. 25791.70, filed on 12/10/2001, (31) U.S. provisional patent application serial no.

60/343,674, attorney docket no. 25791.68, filed on 12/27/2001, (32) U.S. provisional patent application serial no. 60/346,309, attorney docket no 25791.92, filed on 1/7/2002, (33) U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/2002, (34) U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002, (35) U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/2002, (36) U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002, (37) U.S. provisional patent application serial no. 60/391,703, attorney docket no. 25791.90, filed on 6/26/2002, (38) U.S. provisional patent application serial no. 60/397,284, attorney docket no. 25791.106, filed on 7/19/2002, (39) U.S. provisional patent application serial no. 60/398,061, attorney docket no. 25791.110, filed on 7/24/2002, (40) U.S. provisional patent application serial no, 60/405,610, attorney docket no. 25791.119, filed on 8/23/2002, (41) U.S. provisional patent application serial no. 60/405,394, attorney docket no. 25791.120, filed on 8/23/2002, (42) U.S. provisional patent application serial no. 60/412,177, attorney docket no. 25791.117, filed on 9/20/2002, (43) U.S. provisional patent application serial no. 60/412,653, attorney docket no. 25791.118, filed on 9/20/2002, (44) U.S. provisional patent application serial no. 60/412,544, attorney docket no. 25791.121, filed on 9/20/2002, (45) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.128, filed on 9/20/2002, (46) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.127, filed on 9/20/2002, (47) U.S. provisional patent application serial no. 60/412,542, attorney docket no. 25791.102, filed on 9/20/2002, and (48) U.S. provisional patent application serial no. 60/412,488; attorney docket no. 25791.114, filed on 9/20/2002, the disclosures of which are incorporated herein by reference.

[0016] Fig. 1 shows a casing cutter tool 10 in a wellbore casing 14 in a wellbore 12. The cutter tool 10 in a retracted non-cutting configuration and at a location in the wellbore casing 14 below an overlapping joint 16 between an expanded upper casing section 18 and a partially expanded lower section 20. The expanded upper casing section 18 and the partially expanded lower section 20 are in a nested arrangement. The lower section 20 has been expanded into a bell portion 22 formed in the upper expanded section 18 of the wellbore casing 14, thereby forming the overlap joint 16 in preparation for cladding to seal together the upper and lower casing sections 18 and 20. In certain situations, as shown, either purposefully or accidentally, the lower section 16 of casing 14 has an extra portion 24 extending upward into the upper casing section 18 a distance greater than is required for forming an adequate joint 16. The bell portion 22 may be preformed, before the lower casing section 20 is expanded, or may be formed at the same time as the lower casing section 20 is expanded. Where the upper casing section 18 is not previously expanded to form a bell portion 22, expanding the lower section 20 at an overlapping joint 16 would require a significant amount of force and work to expand both the lower casing section 20 and the upper casing section 18 at the same time. Where the expanded bell portion 22 has been previously formed in the upper casing section 18, the subsequent expansion of the lower casing section 20 does not require significantly more force at the joint 16. Thus, a preformed bell portion 22 facilitates the process. Whether

or not the bell portion 22 is pre-formed or formed upon expansion of the lower section 20, it has been found by applicants by providing the cutter tool 10 of the present invention, the expansion of the lower casing section 20 may be terminated after a sufficient length of overlapping joint 16 is formed. This will leave an extra unexpanded portion 24. The cutter tool 10 of the present invention is useful to cut off and remove the unexpanded extra portion 24 of the lower casing section 20. Time and effort need not be expended to expand the extra portion 24 of the lower section 20. Time and effort to carefully calculate and position each next lower section is also saved by simply choosing to always leave a sufficient extra length for the extra portion, knowing that it can be conveniently removed with the cutter tool 10 of the present invention.

[0017] In the exemplary embodiment illustrated, the cutter tool 10 is a modular device including a tubular support 28 that can be attached at a conventional upper coupling 30 axially aligned with a conventional drill pipe or other portion of a down hole string (not shown). Similarly other conventional tools, other conventional expansion tools or other tubular expansion tools as described in patents and co-pending patent applications incorporated above by reference, may be connected at a conventional lower coupling 32. In the illustrated embodiment of the cutter tool 10, cutter blades 34 are expandably attached circumferentially space around the tubular support 28. An expander device 36 is attached to the tubular support for selectively moving the cutter blades 34 to expand or to retract.

[0018] With reference to Figs 1 and 2, the operation of the expander device 36 is shown for expanding the cutter blades 34 from a non-cutting position with the cutter blades 34 retracted radially inwardly (as shown in Fig. 1) to a cutting position with the cutter blades 34 expanded radially outwardly (as shown in Fig.2). Conventional mechanisms for radially expanding tools from a shaft or tubular member may be used to cause cutter blades 34 to move to and from the cutting position. Dummy blades 37 (hidden from view in Figs. 1-6) are provided positioned circumferentially around the tubular support 28 and interleaved with the cutter blades 34. In the illustrated embodiment, the cutter blades 34 are pivotably attached to the cutter tool 10 at a pivot connection 38 and the dummy blades are pivotably attached at a pivot connection 39. The expander device 36 includes a ramp surface 40 for sliding engagement with an interior surface 42 of each of the cutter blades 34. An upper expander cone 44 is provided having a plurality of ramp surfaces 40 for sliding engagement with the interior surfaces 42 of each of the circumferentially spaced cutter blades 34. A torsional force transmitter device 46 is provided to transmit rotational forces between the tubular support 28 and the cutter blades 34. The interleave dummy blades also facilitate maintaining the proper orientation of the cutter blades 34 and transmission of rotational forces there between. The expander cone 44 is supported for axial sliding on a mandrel portion 48 of the tubular support 28 and is axially movable relative to the cutter blades 34. An actuator 50 is provided that is selectively activateable to move the expander cone 44 axially along the mandrel portion 48 so that each ramp surface 40 is moved in ramping engagement with the interior surfaces 42 of each blade 34. It will be understood that the actuator 50 may be a conventional device for actuating relative axial

motion between sliding portions of down hole tools. The relative axial movement causes cutting tips 52 of the cutter blades 34 to pivot radially outward to the cutting position. In the cutting position, the cutting tips 52 of the plurality of cutter blades 34, will define a cutting diameter D that is smaller than the expanded inside diameter ID2 of the lower casing 20 and larger than the unexpanded inside diameter ID1 of the extra portion 24 of the lower casing 20.

[0019] In the illustrative embodiment, shown in greater detail in Fig. 3, the actuator 50 includes a hydraulic device coupled to the expander cone 44 to move the ramp surfaces 40 relative to the cutter blades 34. When the actuator 50 is activated to "open", the cutter blades 34 are moved to the cutting position and when the actuator 50 is activated to "close", the cutter blades 34 are retracted position to the non-cutting position. The actuator 50 has a cylinder 54 and an opening piston 56 coupled to a sliding sleeve 58 that slides relative to the mandrel 48 and engages the expander cone 44. A divider ring 60 is secured to the mandrel 48 for sliding within the cylinder 54 and forms an opening chamber 62 on one side of the divider ring 60, toward the opening piston 56, and a closing chamber 64 on the other side of the divider ring 60, toward a closing piston 66. The closing piston 66 is coupled to the sliding sleeve 58 that engages the expander cone 44 and slides relative to the mandrel 48. An opening port 68 extends between the opening chamber 62 and an up-stream fluid passage 70 through the interior of the mandrel 48. A closing port 72 extends between the closing chamber 64 and a downstream fluid passage 74 in the interior of the mandrel 48.

[0020] An activation device 76 is provided, for example, the activation device may include an opening dart 76A, that is ported to direct fluidic material 78 into and out of the opening and closing chambers 62 and 64. The opening dart 76 provides and entry fluidic passage 80 that is in fluid communication with the upstream fluid passage 72, and seats at seat 82 within the upstream fluid passage 72 axially aligned with the opening port 68 and an annulus 84 to provide a path for fluidic material 78 into the opening camber 62, regardless of the rotational orientation of the opening dart 76A. An exit fluidic passage 86 is also provided in the opening dart 76A. When the opening dart seats at seat 82, the fluidic passage 86 becomes aligned with the closing port 72 and an annulus 88 for allowing fluidic material 78 to escape from the closing chamber 64, and into the down stream passage 74 in the interior of the mandrel 48. Thus, a differential pressure results and the opening piston 56 is moved. Movement of the opening piston 56 causes the sliding sleeve 58 to slide, thereby causing the ramp surfaces 40 to move under and along the interior surfaces 42 of the cutter blades 34. The cutter blades 34 are thus pivoted outwardly thereby moving the cutting tips 52 radially outward to a cutting position. It will be understood based upon the present disclosure that a conventional actuating device for selectively directing fluidic material in a down hole tool may be used as an alternative to the illustrated activation device 76. It will also be understood that a conventional device for otherwise selectively actuating the cutter blades 34 to expand may also be used as an alternative to the actuator 50 without departing form certain aspects of the invention.

[0021] With reference also to Figs 4 and 5, the cutter tool 10 with radially expanded cutter blades 34

is moved axially upward toward a transition area 90 between the lower casing section 20 and the extra casing portion 24. The cutter tool 10 is also rotated within the casing 14. Rotational force is transmitted to the cutter blades 34 and the cutting tips 52 engage with the transition area 90 between the expanded lower casing portion 20 and unexpanded extra casing portion 24.

[0022] In Fig. 6, the lower casing 20 is completely severed from the extra portion 24. The extra portion 24 is supported by the radially expanded tips 52 of the cutter blades 34 and is lifted up and removed from the wellbore.

[0023] Fig. 7 shows an embodiment of the cutter tool 10 activated by a closing dart 76B to retract the cutter blades 34 to a non-cutting position. In situations where the cutter tool 10 needs to be withdrawn from the wellbore casing 14, after it was previously actuated to the cutting position, the opening dart 76A can be blown out with increased fluid pressure and a closing dart 76B can be injected to seat at seat 82. The closing dart 76B provides a relief passage 92 axially aligned with the opening port 68 and annulus 84 to permit escape of fluidic material from the opening chamber 62 so that pressure therein is reduced. Also, a closing passage 94 is aligned with the closing port 72 and annulus 88 to provide fluidic material 78 into the closing chamber 64 so that pressure therein is increased. The closing piston 66 is thus actuated by the differential pressure to move the sliding sleeve 58 to retract the cone 44 and thereby allow the cutter blades 34 to retract radially inward to a non-cutting position.

[0024] Fig. 8 shows a cross-section through an exemplary embodiment of the expander device 36 with cutter blades 34 in the expanded condition. The interior surface 42 of the cutter blades 34 are supported by ramp surfaces 40 of lower cam arms 44a of the expander cone 44. Dummy blades 37 are interleaved with the cutter blades 34 and supported on a upper expander cone 96 with upper cam arms 98. The cutter blades are pivoted, at pivot point 38, outwardly so that cutting tips 52 are at a diameter for cutting the extra casing section 24 (not shown in Fig. 8) as described above. Rotational force is transmitted to the expander device 36 with torsional force transmitter device 46, shown as messing teeth 46a formed at an upper end of upper expander cone 44. The rotation is transferred down the tool to the actuator and sliding sleeve 58 and to any other devices connected below, through another torsional force transmitter device 98 as with meshing teeth 98a.

[0025] Thus what has been disclosed in the several exemplary embodiments is a cutter tool for a wellbore casing including a rotatable tubular support, at least one cutter blade supported on the rotatable tubular support, the cutter blade having a retracted position for insertion into the wellbore casing and an expanded position for cutting engagement with the wellbore casing and an actuator for moving the cutter blade from the retracted position to the expanded position for cutting engagement with the wellbore casing.

[0026] In one embodiment, the cutter tool further includes an expander device coupled to the actuator and the cutter blade is pivotably mounted on the expander device.

[0027] In another embodiment, the cutter blade includes an interior sliding surface and an expander device includes a ramp surface moveable by the actuator along the tubular support in sliding engagement

with the interior sliding surface of the cutter blade to pivot the cutter blade between the retracted position and the expanded position.

[0028] In another embodiment, the cutter tool includes a plurality of cutter blades each pivotably mounted on a expander device and each having an interior sliding surface and wherein the expander device includes an expander cone supported on a mandrel portion of the tubular support and the expander device having a plurality of ramp surfaces slidingly engaged with each interior sliding surface of the plurality of cutter blades.

[0029] In another embodiment of the cutter tool, the actuator for moving the cutter device from the retracted position to the expanded position includes an activation device for selectively activating the actuator to move the cutter blades from the retracted position to the expanded position for cutting engagement with the wellbore casing.

[0030] In another embodiment the actuator includes a hydraulic cylinder attached to the tubular support and coupled to the expander device and wherein the activation device comprises an activation dart seatable within a fluid passage through the cutter tool for directing fluidic material into the hydraulic cylinder to cause relative sliding movement of the expander cone on the mandrel portion of the tubular support.

[0031] In another embodiment the actuator for moving the cutter device from the retracted position to the expanded position further includes means for selectively activating the actuator to move the cutter blades from the retracted position to the expanded position for cutting engagement with the wellbore casing and from the expanded position to the retracted position.

[0032] In another embodiment the actuator includes a hydraulic cylinder attached to the tubular support and coupled to the expander device, the hydraulic cylinder having an opening chamber for moving the cone in an axial direction for expanding the cutter blades and having a closing cylinder for moving the expander cone in an opposite axial direction for retracting the cutter blade and wherein the activation device comprises a first activation dart seatable in the tubular support for directing fluidic material into the opening chamber of the hydraulic cylinder and a second activation dart seatable in the tubular support for directing fluidic material into the closing chamber of the hydraulic cylinder.

[0033] In another embodiment the expander cone has a plurality of first cam arms each providing one a plurality of ramp surfaces each slidingly engaged with a separate one of a plurality of cutter blades and further comprising a second cone having a plurality of cam second arms each having a second ramp surface and interleaved with the first cam arms and a plurality of dummy blades interleaved with the plurality of cutter blades and in sliding engagement with the second ramp surfaces provided on the second cam arms, and wherein the dummy blades are expandable and retractable with the cutter blades and have insufficient thickness to contact the wellbore casing when expanded.

[0034] In another embodiment the cutter blade further includes a cutting tip secured to the cutter blade projecting radially outward when the cutter blade is in the expanded position for cutting engagement

between the cutting tip and the wellbore casing .

[0035] In another embodiment the casing cutting tool includes an upper cam assembly further including a tubular base and a plurality of cam arms extending from the tubular base in a downward longitudinal direction, each cam arm defining an inclined surface, a plurality of upper cutting blade segments interleaved with the cam arms of the upper cam assembly and pivotally coupled to the upper tubular support member, a lower cam assembly comprising, a tubular base, and a plurality of cam arms extending from the tubular base in an upward longitudinal direction, each cam arm defining an inclined surface that mates with the inclined surface of a corresponding one of the upper cutter blade segments, wherein the cams arms of the upper cam assembly are interleaved with and overlap the cam arms of the lower cam assembly; and a plurality of lower dummy segments interleaved with cam arms of the lower cam assembly, each lower dummy segment pivotally coupled to the lower tubular support member and mating with the inclined surface of a corresponding one of the cam arms of the upper cam assembly.

[0036] One embodiment of a method for cutting a wellbore casing includes providing a plurality of cutter blades supported on a rotatable tubular support, placing the plurality of cutter blades in a retracted position, inserting the tubular support into the wellbore casing with the cutter blades supported in the retracted position, actuating the cutter blades in the wellbore to expand into a cutting position engage with the wellbore casing , and rotating the tubular support with the cutter blades supported thereon so that the wellbore casing is cut by the rotating cutter blades.

[0037] In another embodiment a method of radially expanding cutter blades for cutting a wellbore casing in a wellbore is disclosed including supporting the expandable tubular member using a tubular support member and an expandable cutter tool, injecting a fluidic material into the tubular support member, actuating the expandable cutter tool radially outwardly relative to the wellbore casing and into cutting engagement with the wellbore casing using the injected fluidic material.

[0038] In another embodiment a method of radially expanding cutter blades for cutting a wellbore casing in a wellbore further includes rotating the expandable cutter tool in cutting engagement with the wellbore casing when the expandable cutter tool is expanded radially outwardly relative to the wellbore casing.

[0039] In another embodiment, a method of radially expanding cutter blades for cutting a wellbore casing in a wellbore further includes continuing to rotate the expandable cuter tool in cutting engagement with the wellbore casing until an upper portion of the wellbore casing is severed from the wellbore casing, maintaining the expandable cutter tool in the radially expanded position after the upper portion of the wellbore casing is severed, and raising the expandable cutter tool with the severed casing portion supported thereon out of the wellbore.

[0040] In another embodiment a method of radially expanding cutter blades for cutting a wellbore casing in a wellbore is disclosed, wherein actuating the expandable cutter tool radially outwardly relative to the wellbore casing and into cutting engagement with the wellbore casing using the injected fluidic

material, further includes directing the fluidic material from within a portion of the tubular support member to an actuator cylinder to cause the cutting tool to slide axially on ramp surfaces so that the cutting blades are moved radially outwardly.

[0041] Another embodiment of a method of radially expanding cutter blades for cutting a wellbore casing in a wellbore is disclosed, wherein actuating the expandable cutter tool radially outwardly relative the wellbore casing and into cutting engagement with the wellbore casing, wherein the tubular support member includes an upper tubular support member and a lower tubular support member; and wherein actuating the expandable cutter tool comprises displacing the upper tubular member relative to the lower tubular support member

[0042] A further embodiment of a method of radially expanding cutter blades for cutting a wellbore casing in a wellbore is disclosed is disclosed, wherein the expandable cutting tool includes an upper cam assembly including a tubular base, and a plurality of cam arms extending from the tubular base in a downward longitudinal direction, each cam arm defining an inclined surface, a plurality of upper cutting blade segments interleaved with the cam arms of the upper cam assembly and pivotally coupled to the upper tubular support member, a lower cam assembly including a tubular base; and a plurality of cam arms extending from the tubular base in an upward longitudinal direction, each cam arm defining an inclined surface that mates with the inclined surface of a corresponding one of the upper cutter blade segments, wherein the cams arms of the upper cam assembly are interleaved with and overlap the cam arms of the lower cam assembly, and a plurality of lower dummy segments interleaved with cam arms of the lower cam assembly, each lower dummy segment pivotally coupled to the lower tubular support member and mating with the inclined surface of a corresponding one of the cam arms of the upper cam assembly.

[0043] It is understood that variations may be made in the foregoing without departing from the scope of the invention. For example, the teachings of the present illustrative embodiments may be used to provide a cutter for a wellbore casing, a pipeline, or a structural support.

[0044] In several alternative embodiments, a expander device 36 for expansion and/or retraction of the cutter blades 34 is described, a conventional rotary expander device, a conventional compliant expansion device and/or a conventional hydroforming expansion device may used instead of, or in combination with, the expander device 36 for expansion and/or retraction of the cutter blades 34.

[0045] In several alternative embodiments, one or more of the conventional commercially available expander devices available from Weatherford International, Baker Hughes, Halliburton Energy Services, Schlumberger, and/or Enventure Global Technology may be used instead of, or in combination with, the expander device 36 for expansion and/or retraction of the cutter blades 34.

[0046] Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a

manner consistent with the scope of the invention.

Claims

What is claimed is:

1. A cutter tool for a wellbore casing comprising :

a rotatable tubular support;

at least one cutter blade supported on the rotatable tubular support, having a retracted position for insertion into the wellbore casing and having an expanded position for cutting engagement with the wellbore casing ; and

an actuator for moving the cutter blade from the retracted position to the expanded position for cutting engagement with the wellbore casing .

2. The cutter tool of claim 1, further comprising an expander device coupled to the actuator and wherein the cutter blade is pivotably mounted on the expander device.

3. The cutter tool of claim 2, wherein the cutter blade includes an interior sliding surface and the expander device includes a ramp surface moveable by the actuator along the tubular support in sliding engagement with the interior sliding surface of the cutter blade to pivot the cutter blade between the retracted position and the expanded position.

4. The cutter tool of claim 3, wherein the at least one cutter blade includes a plurality of cutter blades each pivotably mounted on the expander device and each having an interior sliding surface and wherein the expander device comprises an expander cone supported on a mandrel portion of the tubular support and having a plurality of ramp surfaces slidingly engaged with each interior sliding surface of the plurality of cutter blades.

5. The cutter tool of claim 4, wherein the actuator for moving the cutter device from the retracted position to the expanded position further comprises an activation device for selectively activating the actuator to move the cutter blade from the retracted position to the expanded position for cutting engagement with the wellbore casing.

6. The cutter tool of claim 5, wherein the actuator comprises a hydraulic cylinder attached to the tubular support and coupled to the expander device and wherein the activation device comprises an activation dart seatable in the tubular support for directing fluidic material into the hydraulic cylinder to cause relative sliding movement of the expander cone on the mandrel portion of the tubular support.

7. The cutter tool of claim 4, wherein the actuator for moving the cutter device from the retracted

position to the expanded position further comprises means for selectively activating the actuator to move the cutter blades from the retracted position to the expanded position for cutting engagement with the wellbore casing and from the expanded position to the retracted position.

8. The cutter tool of claim 7, wherein the actuator comprises a hydraulic cylinder attached to the tubular support and coupled to the expander device, the hydraulic cylinder having an opening chamber for moving the cone in an axial direction for expanding the cutter blades and having a closing cylinder for moving the expander cone in an opposite axial direction for retracting the cutter blade and wherein the activation device comprises a first activation dart seatable in the tubular support for directing fluidic material into the opening chamber of the hydraulic cylinder and a second activation dart seatable in the tubular support for directing fluidic material into the closing chamber of the hydraulic cylinder.

9. The cutter tool of claim 4, wherein the expander cone has a plurality of first cam arms each providing one of the plurality of ramp surfaces and slidingly engaged with a separate one of the plurality of cutter blades and further comprising a second cone having a plurality of cam second arms each having a second ramp surface and interleaved with the first cam arms and a plurality of dummy blades interleaved with the plurality of cutter blades and in sliding engagement with the second ramp surfaces provided on the second cam arms, the dummy blades expandable and retractable with the cutter blades and having insufficient thickness to contact the wellbore casing when expanded.

10. The cutter tool of claim 1, wherein the cutter blade further comprises a cutting tip secured to the cutter blade projecting radially outward when the cutter blade is in the expanded position for cutting engagement between the cutting tip and the wellbore casing .

11. A casing cutting tool comprising :

an upper cam assembly comprising:

a tubular base; and

a plurality of cam arms extending from the tubular base in a downward longitudinal direction, each cam arm defining an inclined surface;

a plurality of upper cutting blade segments interleaved with the cam arms of the upper cam assembly and pivotally coupled to the upper tubular support member;

a lower cam assembly comprising:

a tubular base; and

a plurality of cam arms extending from the tubular base in an upward longitudinal direction, each cam arm defining an inclined surface that mates with the inclined surface of a corresponding one of the upper cutter blade segments;

wherein the cams arms of the upper cam assembly are interleaved with and overlap the cam arms of the lower cam assembly; and

a plurality of lower dummy segments interleaved with cam arms of the lower cam assembly, each lower dummy segment pivotally coupled to the lower tubular support member and mating with the inclined surface of a corresponding one of the cam arms of the upper cam assembly.

12. A method for cutting a wellbore casing comprising :

providing a plurality of cutter blades supported on a rotatable tubular support;

placing the plurality of cutter blades in a retracted position;

inserting the tubular support into the wellbore casing with the cutter blades supported in the retracted position;

actuating the cutter blades in the well bore to expand into a cutting position engage with the wellbore casing ; and

rotating the tubular support with the cutter blades supported thereon so that the wellbore casing is cut by the rotating cutter blades.

13. A method of radially expanding cutter blades for cutting a wellbore casing in a wellbore, comprising:

supporting the expandable tubular member using a tubular support member and an expandable cutter tool;

injecting a fluidic material into the tubular support member;

actuating the expandable cutter tool radially outwardly relative to the wellbore casing and into cutting engagement with the wellbore casing using the injected fluidic material.

14. The method of claim 13, further comprising:

rotating the expandable cutter tool in cutting engagement with the wellbore casing when the expandable cutter tool is expanded radially outwardly relative to the wellbore casing.

15. The method of claim 14, further comprising:

continuing to rotate the expandable cuter tool in cutting engagement with the wellbore casing until an upper portion of the wellbore casing is severed from the wellbore casing;

maintaining the expandable cutter tool in the radially expanded position after the

upper portion of the wellbore casing is severed; and

raising the expandable cutter tool with the severed casing portion supported thereon out of the wellbore.

16. The method of claim 13, wherein actuating the expandable cutter tool radially outwardly relative to the wellbore casing and into cutting engagement with the wellbore casing using the injected fluidic material, further comprises:

directing the fluidic material from within a portion of the tubular support member to an actuator cylinder to cause the cutting tool to slide axially on ramp surfaces so that cutting blades are moved radially outwardly.

17. The method of claim 13, wherein actuating the expandable cutter tool radially outwardly relative to the wellbore casing and into cutting engagement with the wellbore casing, wherein the tubular support member comprises:

an upper tubular support member and a lower tubular support member; and

wherein actuating the expandable cutter tool comprises displacing the upper tubular member relative to the lower tubular support member.

18. The method of claim 17, wherein the expandable cutting tool comprises:

an upper cam assembly comprising:

a tubular base; and

a plurality of cam arms extending from the tubular base in a downward longitudinal direction, each cam arm defining an inclined surface;

a plurality of upper cutting blade segments interleaved with the cam arms of the upper cam assembly and pivotally coupled to the upper tubular support member;

a lower cam assembly comprising:

a tubular base; and

a plurality of cam arms extending from the tubular base in an upward longitudinal direction, each cam arm defining an inclined surface that mates with the inclined surface of a corresponding one of the upper cutter blade segments;

wherein the cams arms of the upper cam assembly are interleaved with and overlap the cam arms of the lower cam assembly; and

a plurality of lower dummy segments interleaved with cam arms of the lower cam assembly, each lower dummy segment pivotally coupled to the lower

tubular support member and mating with the inclined surface of a corresponding one of the cam arms of the upper cam assembly.

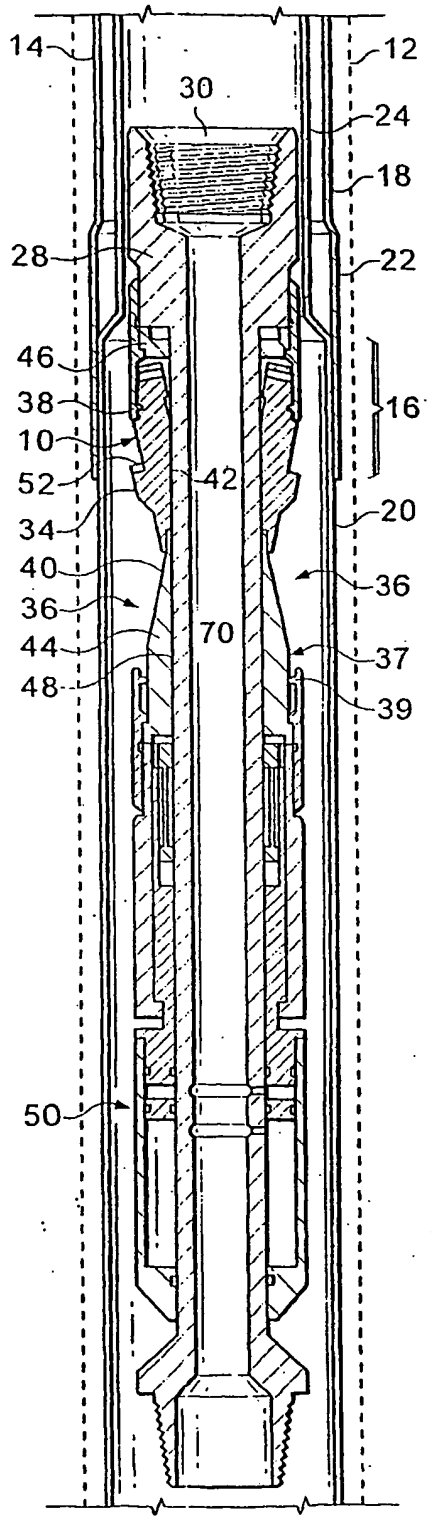
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Fig. 1

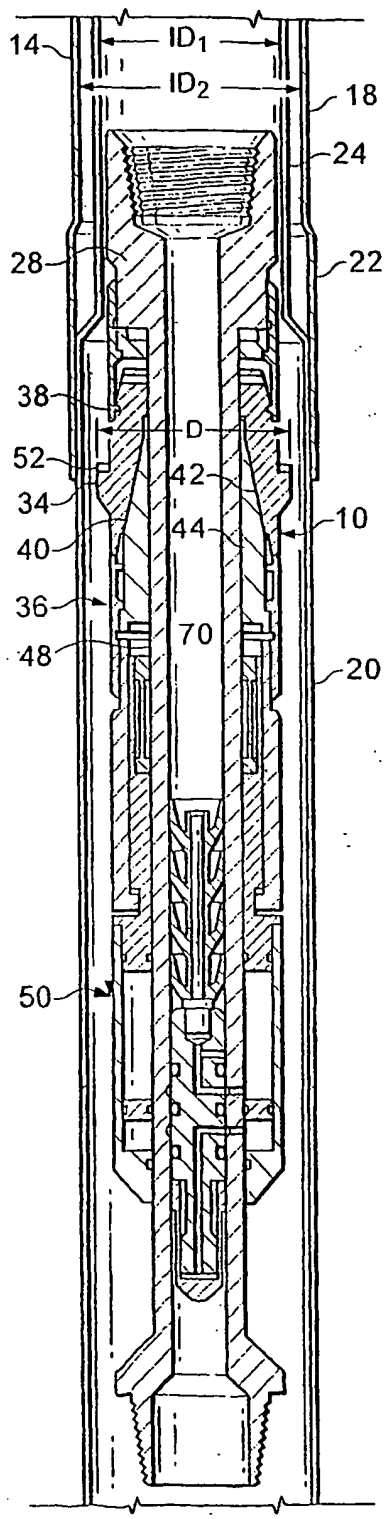
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Fig. 2

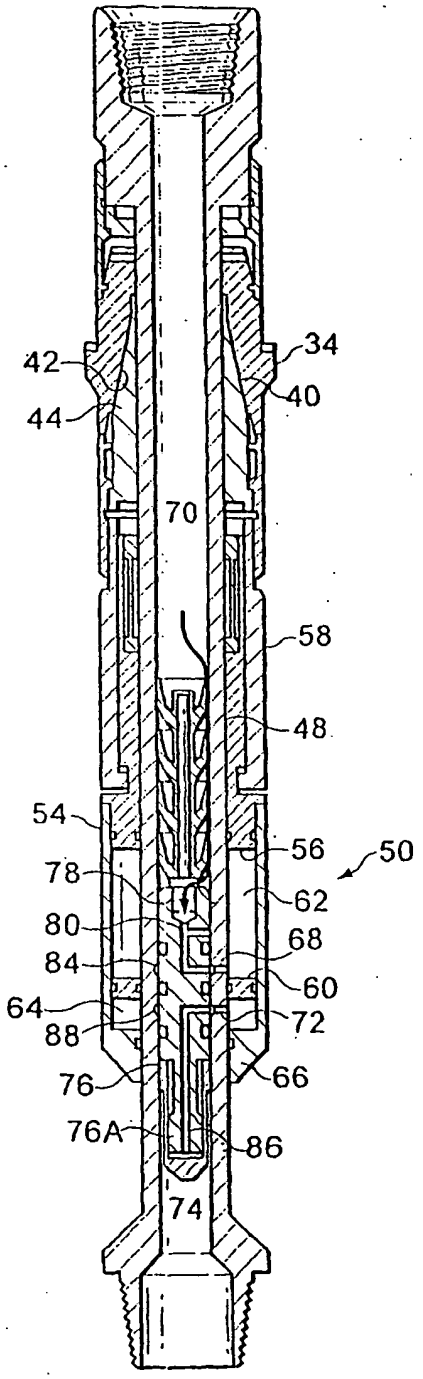
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Fig. 3

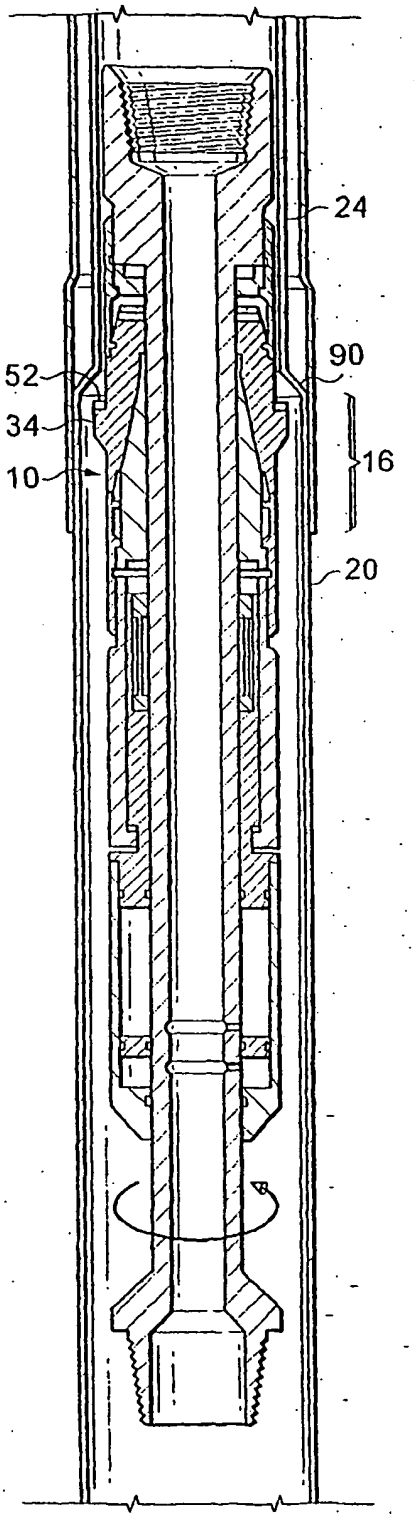
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Fig. 4

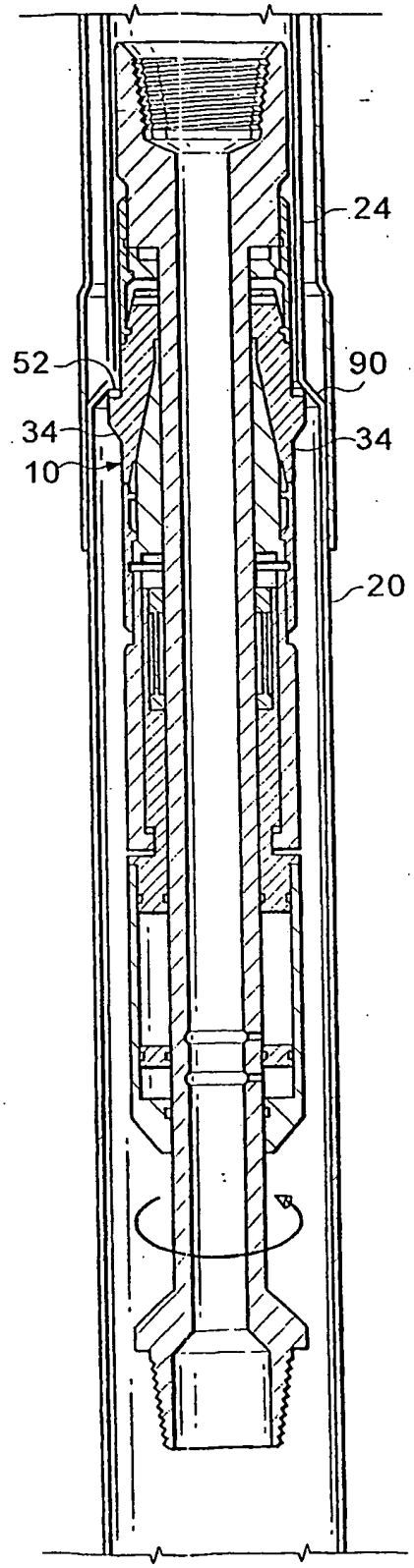

Fig 5

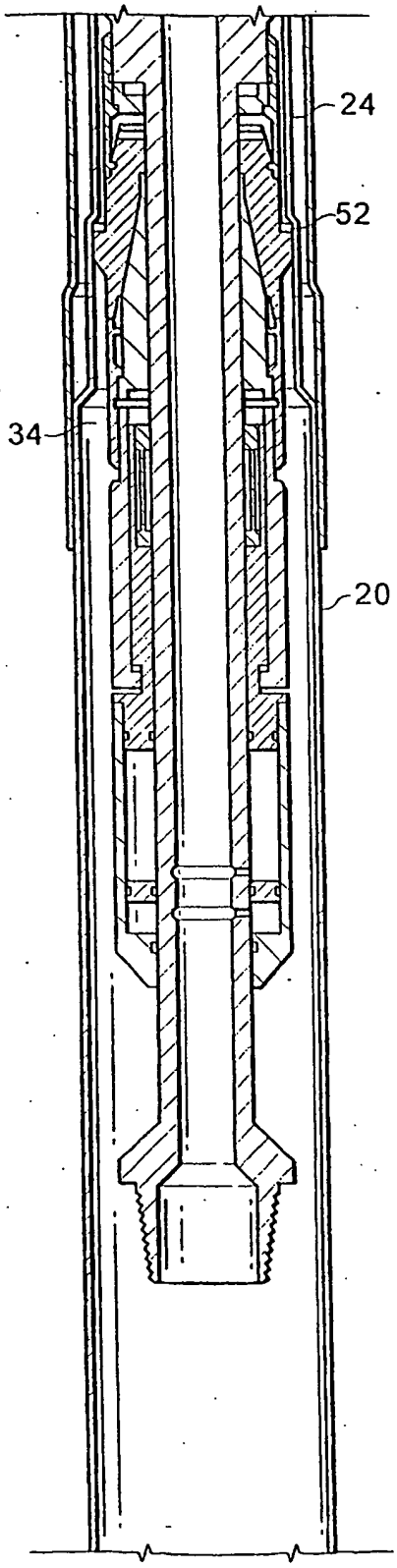

Fig 6

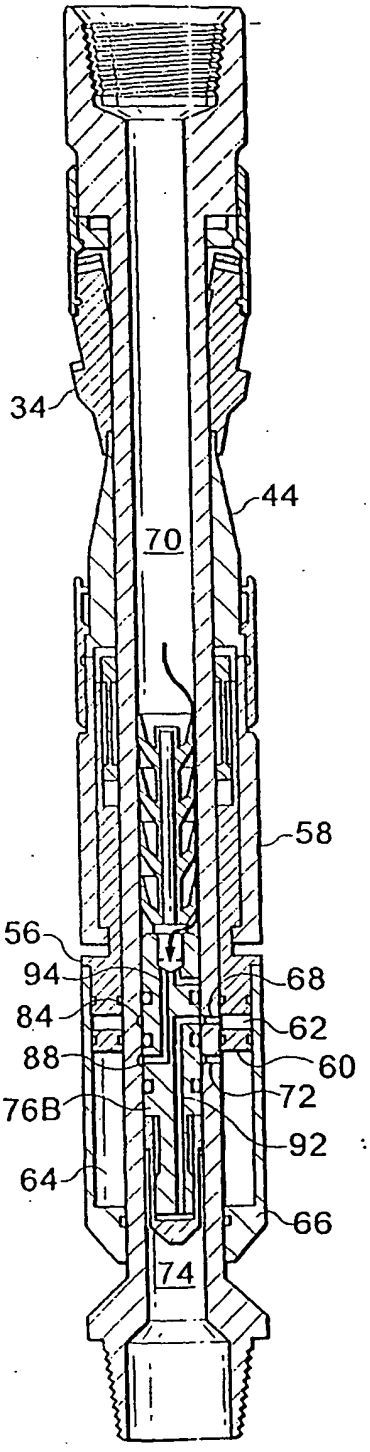
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Fig. 7

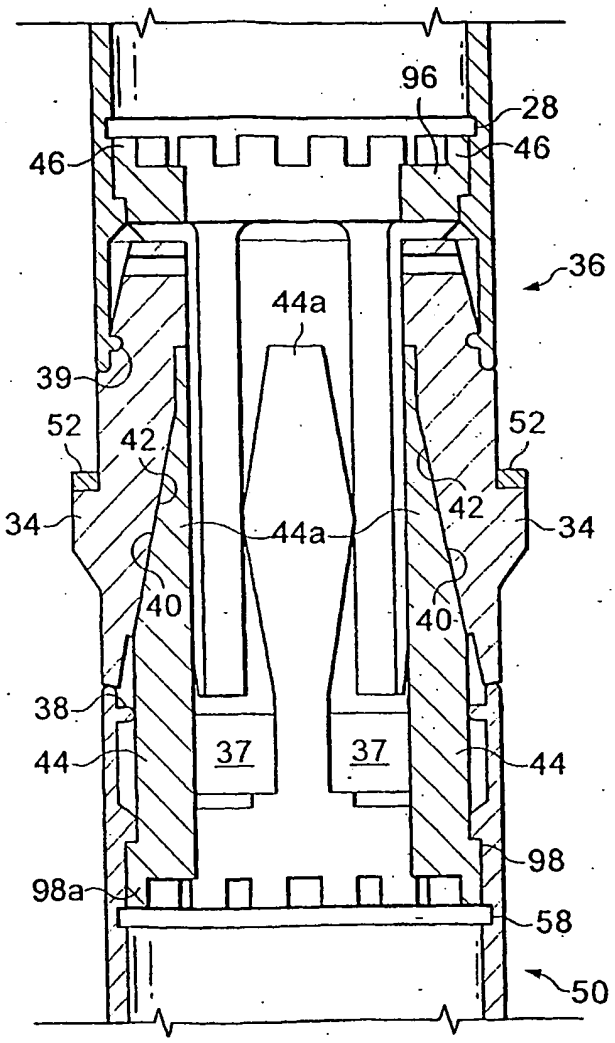
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Fig. 8